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PROTECTIVE CHAFING GEAR FOR SALVAGE OPERATIONS – FIELD REPORT

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May 1980

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AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

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ADMINISTRATIVE INFORMATION

This project began as a result of a two-week Naval Reserve Active Duty in Enewetak Atoll during July 1978 by R. L. Seiple, the Commanding Officer of Reserve Harbor Clearance Unit 620. The initial suits were hand carried and evaluated during the cleanup task. A Navy Science Assistance Program (NSAP) then was initiated by Harbor Clearance Unit One, Pearl Harbor, through COMTHIRDFLT. This task was subsequently given to the Naval Ocean Systems Center Hawaii Laboratory for action. A second reserve tour was taken by R. L. Seiple in August 1979 to complete field evaluation during the cleanup effort. This report summarizes the results of the field evaluation test.

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During the Enewetak Atoll Cleanup Operation the need for protective gear for divers and salvage personnel has been dramatically demonstrated. Protective clothing constructed of Kevlar fabric was designed and tested. Conditions of the cleanup effort are discussed, and the impact of the protective gear is presented.

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OBJECTIVE

Develop chafing gear to protect divers from injury such as cuts and abrasions during salvage operations.

RESULTS

1. A prototype chafing protective wet suit was developed and tested.

2. Test results indicated that with minor modifications the suit can provide excellent protection for divers exposed to the hazardous, sharp underwater debris common to most salvage operations.

RECOMMENDATIONS

1. The Naval Experimental Diving Unit should evaluate the suit as possible standard chafing gear or as MK12 diving dress.

2. NAVSEA should evaluate the suit for other applications in which Navy personnel are exposed to situations which may result in injury to the body.

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BACKGROUND

The protective chafing gear was developed in order to afford protection to underwater salvage divers from cuts and abrasions. The need for such a suit became apparent during the Enewetak Atoll cleanup operation. In this operation the Navy is responsible for clearing all waters from the high-water mark to a depth of 15 feet. The debris, which consists of old, rusty metal remains from the atomic tests and World War II, has been torn apart over the years by the combination of weather and surf action (see figures 1 and 2). Much of the debris had to be blown apart by explosives in order to get it into manageable pieces, as shown in figures 3 and 4. These pieces were removed from the water by handcarrying them to the beach, dragging them up to the high-water line with heavy equipment, and pulling them onto a Launch and Recovery Craft (LARC) as shown in figures 5 and 6. Each of these methods required Navy divers to come into contact with the debris, often in rough surf or high currents. The rigging of explosives under such conditions (figure 7) and hand removal (figure 8) were particularly dangerous. The resulting numerous cuts and abrasions the men sustained often were aggravated by infectious bacteria commonly found in the tropics, such as staphylococcus. As a result, a considerable number of manhours were lost due to the necessity of keeping the wound out of the water and free from infectious material.

It was obvious that suitable protective clothing or chafing gear was necessary. Initially, divers wore long pants, jungle boots, leather gloves and shirt, but these provided only minimal protection and cuts still were commonplace.

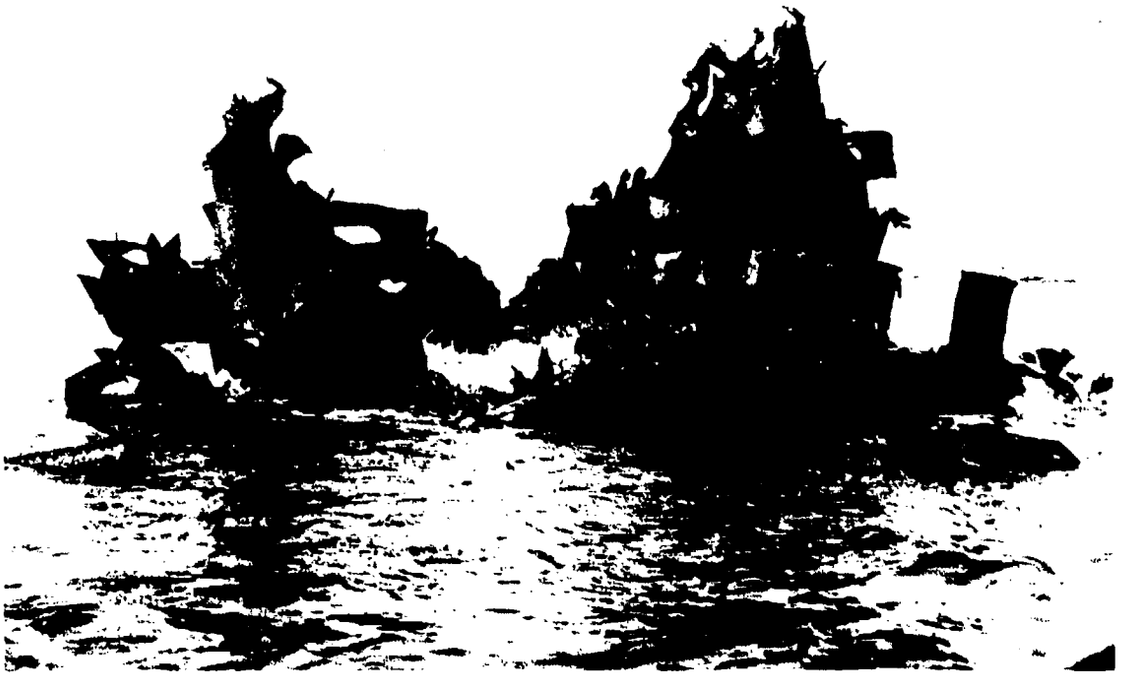

Figure 1. Debris at Enewetak Atoll.

Figure 2. Personnel working on debris at Enewetak.

Figure 3. Rigging demolition charges at Enewetak.

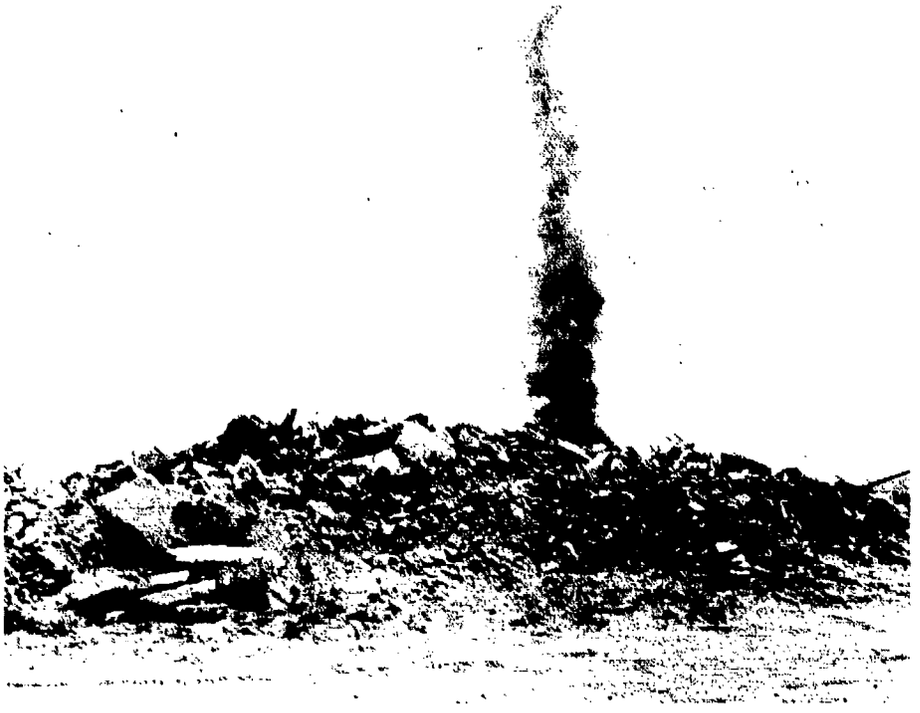

Figure 4. Results of a beach demolition at Enewetak.

Figure 5. Loading debris aboard the LARC.

Figure 6. Loading debris aboard the LARC.

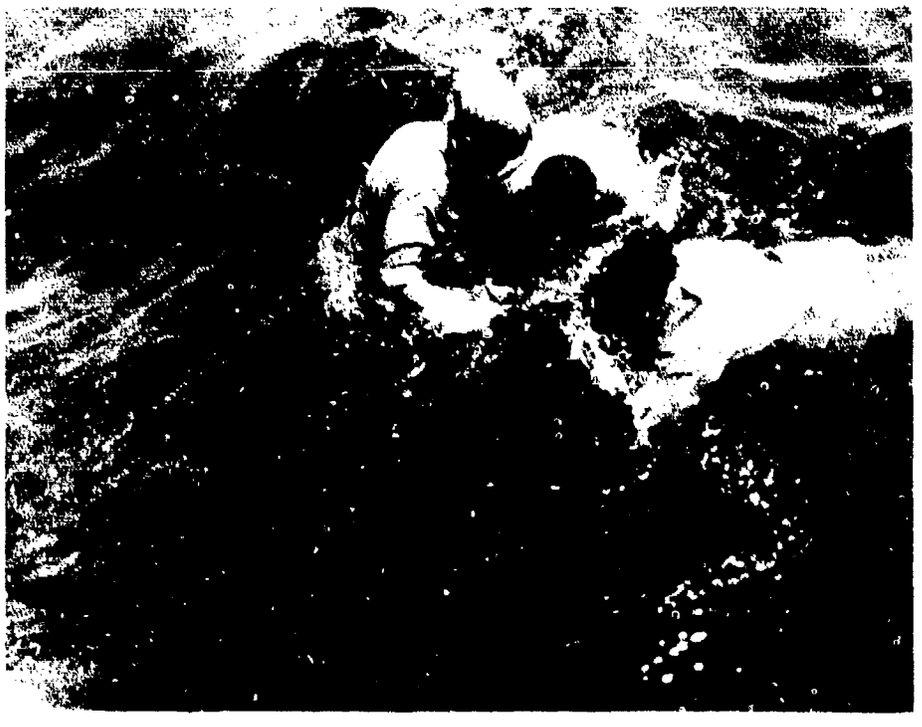

Figure 7. Rigging debris for removal.

Figure 8. Hand removal of debris.

DEVELOPMENT

The strength and resistance to cuts and abrasions of close-weave Kevlar material made it a natural candidate for diver chafing gear (figure 9). A NOSC scientist already had developed and tested Kevlar material as a possible shark protection suit.* Although these suits showed promise, they were too thick and cumbersome for the average diver and in all probability could be used only in special cases. Nevertheless, the suits were taken to Enewetak for evaluation as chafing gear by the cleanup divers. As expected, the suits were too clumsy to wear and too hot for the tropical setting. Still, the material itself showed considerable promise if modified.

A second suit was developed consisting of a single layer of Kevlar. The basic requirements for the suit were that it be lightweight in air and water, flexible, thermally suitable, easy to put on and take off, easy to swim in, and that it offer sufficient protection against punctures. It was felt at the onset of the NSAP task that field tests would be of paramount importance and that laboratory tests of the material would be secondary. There was the danger, for instance, that close adherence to a stringent puncture resistance specification might result in a suit too clumsy to wear under the tough environmental conditions prevailing. Therefore, it was important initially to see how much protection would be afforded by

*Dr. C. S. Johnson, Code 5102.

a close-weave (1000 denier), single-ply suit. Although punctures were possible, the weave was tight enough to provide protection against a 0.025-inch-diameter point at 25 pounds of force. The consensus was that this provided a suitable compromise between weight and protection. Those body areas that were subject to high incidence of cuts and abrasions could have second-ply patching if required. The suits consisted of pants, jacket, hood and gloves. They were equipped with Velcro tabs so that loose areas could be taken up and the size adjusted accordingly.

Figure 9. Prototype chafing gear.

FIELD TESTS

Eight complete prototype suits were sent to Enewetak for field evaluation in April 1979. In August 1979 a final field test was conducted at Enewetak by Navy divers.

PHASE I – APRIL TO AUGUST

The suits, which had been used extensively by the divers during the three-month evaluation period, showed no signs of cuts or abrasions; only some fasteners and straps were torn away from the Kevlar. Although the suits provided excellent protection (no diver experienced cuts or abrasions during this period while wearing the suits), they were too large for the smaller divers and were somewhat difficult to work with in strong currents. Because of the greater effort required to wear the Kevlar suits, the divers stationed at Enewetak found it easier not to wear them, preferring instead to wear their traditional UDT-type tan swim trunks and navy blue and gold tee shirts. Only if the task were unduly treacherous did they wear the Kevlar suits.

The naval reservists who went to Enewetak, however, differed somewhat in their attitudes toward the chafing gear. They used the suits more freely and more extensively, perhaps because they were unaccustomed to the task assigned and were more careful in their approach. Moreover, they were given tasks that required a larger team effort and more personal handling of debris.

PHASE II – AUGUST

Testing during the second phase provided excellent first-hand information regarding the protective suits. The test was conducted during a two-week period, but the most extensive work was performed in two days.

Day One

During this day of testing the divers were required to remove an LCM which already had been blown into smaller pieces by Explosive Ordnance Demolition (EOD) personnel. A US Army LARC was positioned next to the pieces to be recovered (figure 6). The conditions were:

WATER DEPTH: Approximately 4–6 feet.
WATER TEMPERATURE: 80°F.
AIR TEMPERATURE: 95°F.
HUMIDITY: 90%.
WATER CONDITION: Moderate swells, 1–2 feet.
WATER VISIBILITY: Excellent at onset; poor after debris was stirred.
CURRENT: Approximately 1/4 knot.
TEAM TIME IN WATER: 2 hours 13 minutes.

The suits were supplied to half the divers and deck handlers (figure 10). Jungle boots were worn. In some cases divers wore only pants or tops, simply for familiarization .

Figure 10. Divers adjusting chafing gear.

A total of 13 minor cuts or abrasions were experienced during this operation. Of the 13 cuts, only one was experienced through the Kevlar, and that was a minor puncture wound through the knit-type glove. The suits generally were found to be comfortable to wear under these conditions. Many of the divers said repeatedly they would have been cut, and sometimes seriously, had it not been for the suits. One comment was that the suits gave the divers somewhat more freedom in working around the sharp debris because they had the feeling they were better protected. Divers stated that the suits were thermally comfortable because water circulated freely through them.

On the other hand, the Velcro tabs came unfastened at times. Twice the Kevlar material snagged on the debris, and the divers had some difficulty freeing themselves. The suspender straps holding the pants up broke in several suits. During the first day the divers wore the suits at their discretion, and generally were indifferent and unconcerned as to whether to wear them or not.

Day Two

During the second test day the suits, which again were used to recover parts of the debris remaining from the first day, were in high demand. At the dive site, divers entered the water with suits and jungle boots (no fins) and found immediately that they could not move freely with the suits because of an estimated current of 1.5 knots caused by the incoming tide. The loose-fitting nature of the suits acted like a sea anchor, and swimming, especially without fins (a customary practice in water shallower than six feet) was nearly impossible. With fins, working with the suit still was difficult, and finally all suits were taken off. It was suggested that suit sizing would eliminate or reduce the problem of working freely in strong currents.

SUMMARY

The chafing protective wet suit prototype, as shown in figures 11 and 12, clearly demonstrated that with certain minor modifications it can be an excellent protective suit for divers exposed to the hazardous sharp underwater debris common to most salvage operations. The suits received considerable field abuse; yet they held up extremely well with the exception of straps and some fasteners. The gloves, however, required longer sleeve length for additional protection

Figure 11. Trousers after use.

Figure 12. Gloves after use.

RECOMMENDATIONS

It is recommended strongly that the Naval Experimental Diving Unit evaluate this suit carefully as a possible standard chafing gear for salvage divers or as MK12 diving dress. Also, it is suggested that NAVSEA evaluate this suit for other applications where Navy personnel are exposed to situations that may result in injury to the body. Such suits may be used as injury control suits, flight suits, and as dress for similar activities.

RECOMMENDED SUIT MODIFICATIONS

1. A coverall-type design may be better suited for certain applications.

2. Gloves should have longer sleeve extensions.

3. Knitted gloves tended to hang up on debris; therefore, it is recommended that they be worn under standard gloves.

4. Rubber-impregnated Kevlar or similar material should be examined. This may eliminate snagging on sharp debris (a problem which exists with most chafing gear).

5. Three sizes should be available, instead of one-size-fits-all. This would reduce material folds which cause additional drag in high current conditions.

6. Pockets should be eliminated, since they were not used.

7. Larger suspenders with more sturdy fasteners should be provided.